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TITLE

Dynamics of Frontal Intrusions and their effects on a Mediterranean Salt Lens.

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ABSTRACT

GOALS

Parameterisation of the structure, amplitude, and mixing rate of finite-amplitude lateral intrusions. These occur at most oceanic fronts, including the Gulf Stream, and drive cross-frontal mixing. The highly structured quasi-horizontal sound speed perturbations may strongly affect acoustic propagation across such fronts.

OBJECTIVES

1. To understand the role of vertical mixing of salt, heat, mass, and momentum in driving lateral intrusions.

2. To predict the scale, structure, and magnitude of finite-amplitude intrusive features in terms of mesoscale gradients.

3. To predict the rate of lateral transport of salt, heat, and momentum caused by intrusive mixing at oceanic fronts.

APPROACH

1. To follow the Meddy "Sharon" intrusions across isopycnals and compare slopes with those predicted by linear models in order to determine their dynamical driving mechanisms.

2. To map the scales and structures of the Meddy "Sharon" intrusions, and investigate changes over the period of observation.

3. To develop a simple numerical model of finite amplitude intrusions.

4 To use the numerical model and associated theoretical modelling to understand the finite-amplitude balances which control lateral fluxes.

TASKS COMPLETED

1. Achieved.

2. Achieved. The vertical wavelength and intensity of intrusive interleaving has been mapped out for each of the Meddy surveys. A paper describing the intrusion structure and its time evolution is in preparation.

3. Achieved. A one-dimensional numerical model of finite-amplitude thermohaline intrusions has been developed, and is currently being tested to ensure that it successfully reproduces the properties of the known linear instabilities.

4. In progress. This task could not begin until the numerical model was ready.

RESULTS

1. The scale and slopes of the intrusions were found to support theoretical models of thermohaline driving, and showed definitively that the intrusions were NOT driven by the McIntyre mechanism (differential diffusion of momentum and mass). (Ruddick, 1991a)

2. (a.) The intrusions had longer vertical wavelength in the lower part of the Meddy than in the upper part. (b.) We found that it was possible to observe the perturbations in density which drove the intrusive motions (see accomplishment 2).

ACCOMPLISHMENTS

1. In one closely-spaced sequence of stations, individual intrusions were tracked across isopycnals. The pattern and magnitude of intrusion slopes proved that the McIntyre (1971) mechanism involving differential diffusion of momentum and mass did not drive the Meddy intrusions. The slope pattern and magnitude supported current ideas of lateral intrusions driven by vertical double-diffusive fluxes. (Ruddick, 1991a, 1991b)

2. We are able to "see" the density perturbations which drove the intrusions! In most CTD stations from the Meddy intrusions, small perturbations in vertical density gradient were found to correlate with the local vertical "spiciness" gradient (indicative of double-diffusion). The phase relation between the two changed sign with the intrusion slope, and strongly supports the contention that these density perturbations are real, not instrumental, and drove the intrusions up-or down-slope. (See figure 1.) We plan in the near future to use these results to quantify the frictional forces acting within the intrusions.

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